DEPOSITIONAL AND EXPOSURE HISTORY OF THE APOLLO 17 DEEP DRILL CORE.
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INTRODUCTION

The Apollo 17 deep drill core was rotary-percussion drilled into the lunar regolith about one crater diameter east of the ~650 m diameter Camelot Crater. The ~300 cm length of regolith in the core (sections 70009 through 70002 and drill bit 70001) is the longest vertical section of regolith so far returned from the Moon (1).

Previous studies of samples from some or all of the sections of the core include neutron fluence (2, 3), rare gas (4), petrography (5, 6, 7, 8) chemistry, (9, 10), and particle tracks (11, 12). In this study, we report values of FeO and the surface exposure index $I_g$/FeO for 491 soil samples from core sections 70009 through 70002; our ~25 mg samples originate from virtually every dissection interval (usually 0.5 cm) in the core sections, except for 70008 where soil was obtained from every other dissection interval. Depth profiles of our data provide high depth-resolution data on vertical variations of composition (as indicated by the major element FeO) and relative duration of surface exposure of soil in the core. Within the constraints of this and other data indicated above, we will present a model for the depositional and exposure history of the core.

EXPERIMENTAL PROCEDURES AND RESULTS

The experimental procedures are described by (13, 14). The depth profile data are processed by a three point sliding average according to (15).

The depth profiles of FeO and $I_g$/FeO for the Apollo 17 deep drill core are shown in Fig. 1. For purposes of comparison, histograms of FeO and $I_g$/FeO for Apollo 17 surface/trench soils are also shown (data from (16)); the stippled portion denotes soils obtained from the Valley floor, excepting soils collected on the avalanche. Some salient features of the depth profiles are discussed below.

The most mafic soil in the core is found in the upper ~75 cm and contains as high as ~19.0% FeO. The most felsic soil in the core is found in the lower two-thirds of section 70003 and contains as little as ~14.0% FeO. These most felsic soils contain as a crude estimate 50% highland component if, after (17), 7.0% and 19.0% are adopted as the FeO concentration of "pure" highland and mare soils. Note that the range of values of FeO in the core is as wide as the range of values for the entire Valley floor. However, most of the soil in the core has ~15.5% FeO. (10) report FeO concentrations for some samples from sections 70009 through 70006; their results are comparable to ours.

The maturity (i.e., degree of surface exposure) of soil in the core spans a range comparable to that for the Valley floor surface/trench soils. The most mature soils in the core are mature, have values of $I_g$/FeO<30 units, and are located between 115 and 160 cm and again at ~275 cm. The least mature soils are immature, have values of $I_g$/FeO<9 units, and are located between ~25 and 50 cm; they are also the most mafic soils in the core. The majority of the soils in the core are submature to mature, and it is evident there is a great deal of structure in the $I_g$/FeO depth profile. For example, there is particularly sharp contact at ~110 cm. For the core sections where agglutinate and track data are available (e.g., 6, 11, 12), they exhibit similar trends to the $I_g$/FeO data, as expected since they are also surface exposure indices.
Previous Models

Many investigators have proposed models for the depositional and exposure history of the entire or portions of the Apollo 17 deep drill core. (4) argue that either long-term continuous accretion or rapid deposition models may be possible within the constraints of their cosmogenic rare gas data and the then-available neutron fluence data. (3) using neutron fluence data, some of which...
was not available to Pepin et al., negate the long-term continuous accretion model and conclude the rapid deposition model is the most likely description of the depositional history of the core. (6) advocate a model in which the entire core was rapidly deposited in a few events all occurring \simeq 100 \text{ m.y. ago}; we see no fundamental difference between this model and that of (3). (11) argue from data including track densities that at least the immature layer (primarily section 70008) was implaced by one event \simeq 100 \text{ m.y. ago}. They further argue that the soil above the immature layer has been disturbed within the last \simeq 100 \text{ m.y.} (18) adopted a model in which at least the upper \simeq 50 \text{ cm} of the core was deposited \simeq 100 \text{ m.y. ago} and at that time the entire upper \simeq 50 \text{ cm} was immature; in the subsequent \simeq 100 \text{ m.y., in situ} reworking (gardening) progressed to a depth of \simeq 26 \text{ cm}, creating the presently observed "higher-maturity" zone at the top of the core. We do not believe the views of (11) and (18) for the top of the core are contradictory; we would argue that the 2 \text{ m.y. event} and subsequent crater filling discussed by (11) are just part of the in situ reworking process.

**Present Model**

We believe the $\text{I}_g$/FeO profile is not very compatible with a continuous long-term accretion model; such a model should give smooth variations in $\text{I}_g$/FeO and not the numerous sharp contacts observed in the $\text{I}_g$/FeO depth profile. For rapid deposition (one event or sequence of closely spaced events), the resulting values of $\text{I}_g$/FeO are governed by the predepositional values of $\text{I}_g$/FeO and mixing effects during deposition. If the one event or sequence of closely spaced events sampled strata of different values of $\text{I}_g$/FeO, then sharp contacts are expected.

We suggest the following model as the most likely description of the depositional and exposure history of the Apollo 17 deep drill core: (a) Rapid deposition by one event or sequence of closely spaced events, all occurring \simeq 100 \text{ m.y. ago}. At that time, the FeO and $\text{I}_g$/FeO profiles below \simeq 26 \text{ cm} were the same as they are now; between \simeq 26 \text{ cm} and the surface, however, FeO$\sim 18\%$ and $\text{I}_g$/FeO$\sim 9$ units. The soils also have their present neutron fluences and concentrations of cosmogenic rare gases minus an amount acquired during the \simeq 100 \text{ m.y. of the next stage}; that is, the soils, especially below \simeq 100 \text{ cm}, were heavily pre-irradiated. (b) In situ reworking (gardening) to a depth of \simeq 26 \text{ cm} between \simeq 100 \text{ m.y. ago} and the present. In situ reworking raised the maturity of soil in the upper \simeq 26 \text{ cm} to the present values and, through the lateral transport associated with in situ reworking, mixed in sufficient highland material to slightly lower the FeO concentrations in the upper 26 cm to \simeq 17\%. The 2 \text{ m.y. event} described by (11) is one of the events that was part of the in situ reworking of the Apollo 17 deep drill core.

**REFERENCES**


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